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Using Participatory Multi-Criteria Assessments for assessing Disaster Risk Reduction Measures

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Abstract: This paper introduces a participatory Multi-Criteria Assessment (MCA) methodology developed through the Resilience Increasing Strategies for Coasts – Toolkit (RISC-KIT) project and implemented in nine case studies in Europe. The purpose of the MCA was to bridge the disciplinary divide between engineering sciences and social sciences, facilitate the communication and dissemination of local coastal risk assessments and Disaster Risk Reduction (DRR) measures' evaluation to a broad range of actors. The process addressed the importance of integrating scientific knowledge with stakeholders' knowledge to understand and assess the possible social, political and economic implications of different DRR measures, which could foster or hinder successful implementation. The paper discusses the methodological aspects and implementation of the approach which included visualizing risk reduction of DRR measures using paper-based cards to support interaction and negotiation among participants to select preferred strategic alternatives (SA), and a participatory MCA where stakeholders evaluated the SA against three (self-weighted) criteria: feasibility, acceptability and sustainability.

Keywords: Participatory Approaches; Multi-Criteria Assessment; Disaster Risk Reduction; Coastal Hazards; RISC-KIT.

1. Introduction

Disasters are increasingly uncertain and complex due to rapid environmental and socio-economic changes occurring at multiple scales [1]. Adequate management responses able to address these challenges in coastal areas demands both a growing body of knowledge on coastal hazards and their impacts, as well as an understanding of local socio-economic and institutional preconditions [2]. Approaches combining protective (e.g. dike protection) with preventive (e.g. spatial planning), and preparedness (e.g. early warning system) measures are crucial to be able to face current and future coastal challenges. However, the adequacy of DRR measures depends not only on the technical implementation of them, but also on an understanding of the physical, political and socio-economic contexts in which these measures are being proposed, as well as their potential benefits or drawbacks. To be able to assess the trade-offs between socio-political, environmental, and economic impacts of decisions in DRR, it is necessary to consider the various and sometimes divergent views of stakeholders involved in coastal management.

Institutional determinants, such as information and skills, economic resources, technological capacity, as well as the equitable distribution of and access to decision making, financial resources and capacity for flood alleviation, have a strong impact on the effectiveness of DRR measures and on the financial capacity for implementation at different governmental levels [3]. Here, local governments play a key role in coastal management, both as the main managers of socio-technical infrastructure and through their responsibility for long-term physical planning [4]. For instance, the extent of induced damage does not only depend on the extent of the hazard but also on the ability of social institutions and managing authorities to cooperate in the implementation of disaster prevention, preparedness and response measures [5,6].

Besides institutional factors, daily experiences and local knowledge of people using resources in risk-prone areas, have proven to be detrimental for determining whether policies and measures will be accepted or not [7], in generating support for initiatives for mitigation and adaptation [8], and in making vulnerability mapping more locally relevant and reliable [9].[1] Thus, involvement of community members and key actors through participatory methodologies are crucial for integrating opinions in the formal decision-making process because the ability to reduce risk from hazards will depend to a large extent on the political, economic and technological capacities that actors involved in coastal management have at their disposal. Furthermore, limits for adapting to climate change are endogenous to society and hence contingent on ethics, knowledge, attitudes to risk, and culture [11]. This means that regardless of how effective scientific studies show a risk-reducing measure might be, changes will be implemented only if they are perceived as meaningful within a culture, feasible in the particular political setting, and socially accepted.

The present paper introduces the methodology developed and used in RISC-KIT to facilitate stakeholder involvement in the project. The methodology comprises of i) an interactive tool based on paper cards for presenting complex information on coastal risks and measures; and ii) a participatory MCA methodology to assess the feasibility, acceptability, and sustainability of the proposed DRR measures in each of the nine RISC-KIT cases: Kiel Fjord in Germany; North Norfolk in the United Kingdom; Porto Garibaldi and Bocca di Magra in Italy; Praia de Faro in Portugal; Kristianstad in Sweden; La Faute Sur Mer in France; Varna in Bulgaria; and Tordera Delta in Spain.

2. Multi-Criteria Assessments for evaluating DRR measures

MCA techniques include decision models which contain “a set of decision options which need to be ranked or scored by the decision maker; a set of criteria, typically measured in different units; and a set of performance measures, which are the raw scores for each decision option against each criterion” [12]. MCAs provide a systematic methodology that combines technical knowledge on benefits and trade-offs of particular choices with locally-relevant criteria. They are most often used to quantify actors’ considerations about (mostly)

[1] In RISC-KIT vulnerability is understood as the conditions and capacities that make a system susceptible to harm as a result of a hazard [10]

non-monetary factors in order to outweigh different courses of action [13]. Cost Benefit Analysis or Benefit-Cost Ratios is another method/approach used to compare measures and justify investments [14]. In contrast to Cost-Benefit analyses, MCAs are deemed suitable when the benefits (e.g. saving lives, biodiversity) cannot be quantified and valued purely in monetary terms [15].

An MCA will typically assess measures using different criteria or indicators which address the identified problem and defined objectives. It is used to help decision-makers compare and prioritize a range of individual or groups of measures, together with a group of actors. To do this effectively the problem must be identified and the objectives defined [16]. A participatory MCA can aim to achieve different levels of participation from the actors involved. Using the concept of 'ladders of participation' developed by Arnstein [17] and adapted by Basco-Carrera [18] for water resources management, possible levels of participation are; ignorance (non-participation), awareness, provide information, engage in consultation (low participation), two-way discussion, co-design or co-decision making (high participation). Typically a participatory MCA should aim for one of the steps in high participation; two-way discussion, co-design or co-decision making. While MCAs do not necessarily need to be participatory [19], adopting a participatory approach ensures transparency, increases the likelihood of engagement, and provides a platform for moderated discussion [20,21].

MCA techniques have proven beneficial to, for example optimize policy selection in water and coastal resource management [22], and to improve the transparency and analytic rigor of the decision-making process which leads to increased public acceptance of the proposed alternatives [22,23]. MCAs can be helpful in socio-ecological evaluations [24] because they can help structure an assessment of complex problems along both cognitive and normative dimensions, both of which are fundamental when evaluating social-ecological systems [25]; they facilitate comparison of ecological objectives with socio-cultural and economic ones in a structured and shared framework [26]; they can facilitate multi-stakeholder processes, transparency and discussion about subjective elements in policy analysis, including the nature and scope of the problem related to decision-making, the selection and definition of options (i.e., measures), and the characterization and prioritization of evaluation criteria [27]; MCA techniques can facilitate dealing with incomplete information (often present in most environmental planning situations) by allowing the use of a mixed set of quantitative and qualitative information [28].

The aim of the MCA in RISC-KIT is to map the diversity of perspectives that may be taken on a particular set of measures, to highlight the key features underlying the differences in opinions and to provide a framework for debate. More specifically, the MCA in RISC-KIT is used in three ways: 1) as a way facilitate the communication and presentation of project results in a coherent and contextualized manner to various actors; 2) as a way to capture other types of knowledge, such as local every-day experiences, socio-economic and political factors that might affect how the proposed measures are perceived; and 3) as a way of facilitating interaction between actors and raising awareness of risks and potential measures.

2.1 Stakeholder selection

In this paper, we use the concept of stakeholders to refer to actors from different groups of society that directly or indirectly might affect or be affected by coastal risks, or have an interest in being included in the discussion. However, we use the concept cautiously and aware of critical approaches highlighting the neoliberal nature of the term [29]. In light of these discussions, we do not claim to involve all affected parties in the RISC-KIT project and we do not seek to achieve representativeness since the aim of the work being presented here is not to make a decision but to engage in an exercise that stimulates knowledge exchange.

Stakeholder identification is a crucial step in any participatory methodology [30,31]. In MCA methodologies, the type of stakeholders involved in the process depends on the aims of the study and can thus be limited to decision-makers or can be open to other type of actors deemed relevant, including the private sector, citizens, or associations. However, there is an increasing recognition of the need to include a broad spectrum of stakeholders in decision making (not only decision-makers), especially in relation to urgent societal–environmental problems, such as adaptation to climate change [32,33]. This recognition emerges from the acceptance of other forms of knowledge, not just scientific or technical, that allows policy-making to take into consideration traditional forms of knowledge and every-day experiences of people. In RISC-KIT we adopt this latter approach.

We depart from 9 main stakeholder groups (SH) identified through a stakeholder analysis carried out at the beginning of the project and further described in Table 1. The stakeholder groups included are; coastal managers, land use planners, civil protection authorities, academics, consultants, local residents, local citizen groups, local government authorities and private sector representatives. Because the role of each stakeholder will vary across contexts, we also defined different roles which stakeholders could potentially fulfil. For instance, coastal managers will probably not have the same role across case studies (e.g. not all coastal managers are decision-makers throughout the 9 RISC-KIT cases). While stakeholders could only represent one of the nine (stakeholder) groups, they could play more than one role. Also, it is likely that one of the roles is more predominant than the other. Seven potential stakeholder roles have been defined; decision-makers, lobbyists, informed receptors, overseers, implementers, experts and private sector. For instance a stakeholder representing the group “consultant” could have the role of “private sector” in some cases, or “overseer” in others.

A root definition of the different roles stakeholders could play is as follows: **Decision-makers** refer to stakeholders in a position to take and execute decisions over a society or community at different (local, national, regional) levels. They may include government ministers, state agencies and departments, senior figures in national or local administrations, members of parliament, donors and their governments. **Lobbyists** constitute a broad category that refers to individuals, associations and organized groups attempting to influence decision-making and advocate particular DRR strategies. Lobbyists can include individuals in the private sector, corporations, legislators, parliamentarians, government officials, advocacy groups (interest groups), funding agencies, or multi-stakeholder partnerships between state and non-state actors. **Informed receptors** are individuals or groups directly benefited or negatively impacted by the implementation of the measure who are actively engaged in DRR debates in the community and might act as representatives of an association or group of citizens. It may include local communities, vulnerable groups, minorities, particular sectors of society (e.g. disabled, children, women, etc.), or economic groups like fishermen or farmers. **Overseers** are individuals, organizations, or associations with the mandate to support, supervise or coordinate the decision-making process of DRR activities. Overseers can include public agencies, ministries, or international organizations, and their tasks may include gathering political support, enhancing parliamentary cooperation, promoting capacity building, improving DRR set-ups, strengthening legislative frameworks, and ensuring adequate budget allocations. **Implementers** are managing units in charge of the execution of DRR-related activities working closely to or at the field site (the locality). This category may include government officials, national institutions, Non-Governmental Organisations (NGOs), regional organisations, civil protection authorities amongst others. **Experts** refer to actors producing and sharing DRR-related knowledge such as researchers, consultants, think tanks, or journalists. The **private sector** includes individuals or corporations that are either involved in DRR, should be involved in DRR, or are highly relevant for planning and implementing DRR measures. One obvious example is insurance companies, but also the tourist industry, energy (gas or oil) or electricity providers, extractive or food-producing companies that may potentially be affected by hazards and could contribute to risk management.

Table 1 Description of the nine stakeholder groups

Stakeholder groups	Description	Why they need to be engaged
SHI: Coastal manager	High-knowledge of both coastal processes and the communities at risk. Involved in coastal protection and defence against flooding and erosion.	To understand the risks associated with the study area in both physical and social contexts.
SH2: Land use planners	High-knowledge of local policies and policy processes involved with regulating coastal land use.	To understand the local polices, as well as processes and stakeholders involved in policy development.
SH3: Civil protection agency/ disaster management agency	High – knowledge of local DRR plans including technical and non-technical measures for disaster risk management. Planning and preparation for safety of citizens as well as property during an extreme event.	To understand local DRR plans and non-technical measures taken in the case of an event.
SH4: academic working in coastal zone	Medium – high knowledge of coastal processes, policies and/or DRR measures. Researching, consulting, and/or working with local planners and managers.	To obtain and understand additional information in regard to design and implementation of the local environment, policy processes, and DRR measures.
SH5: Consultant previously engaged in managing the coastal environment	Medium – high knowledge of coastal processes, policies and/or DRR measures. Researching, consulting, and/or working with local planners and managers.	To obtain and understand additional information in regard to design and implementation of the local environment, policy processes, and DRR measures.
SH6: Local resident previously affected by the hazard	Medium – high knowledge of historical context of case study site, understanding of local environment, cultural and social context.	To understand the needs/perceptions/values of the local population and to learn about past events. Will also provide information on what is politically feasible in terms of the local community.
SH7: Chairperson of local active citizen groups	Low – medium knowledge of local environment, political process and DRR measures. May be involved in	To understand the needs/perceptions/values of the local population and to learn about past events.

	consultation but little further involvement.	Will also provide information on what is politically feasible in terms of the local community.
SH8: Local authority (e.g. port, tourism board, fishing, housing)	High-knowledge of coastal activities (i.e. sectors) as well as political processes and the local communities.	To understand the local socioeconomic activities, political processes and sectoral policies. Will provide data and knowledge on sociocultural, socioeconomic and socioecological aspects of the study area.
SH9: Representative from private sector	Medium-high knowledge of hazards and the real and potential economic losses deriving from risks.	To increase our understanding of economic impacts of hazards and how to achieve public-private partnerships that can produce innovative solutions to risks.

2.2 Selection of criteria

Criteria have been selected based on a literature review of the most important factors when contemplating, planning, financing, and implementing DRR measures. Studies identify factors such as social acceptance, political will, availability of financial resources and technological know-how, as crucial for increased investments in DRR measures (Davis et al. 2015). Particularly, social acceptance seems to be the most crucial factor when planning DRR measures. Governments are accountable to voters and tax-payers that can either support or oppose investments in DRR. Investments in DRR, particularly preventive measures, are often difficult to grasp unless disasters occur. But acceptance can be created through information dissemination and by presenting costs and benefits of measures for different groups, in different sectors, throughout time. However, benefits and trade-offs of measures need to be grounded in context (Shreve & Kelman 2014), because the applicability and relevance of a measure will not only depend on foreseen gains or losses, but on whether the measure is likely to be accepted, prioritized, and supported (in a given socio-political landscape) to begin with. Some measures might make perfect sense when looking at the physical conditions, but will never be implemented because of strong local opposition; other measures might initially seem adequate to prevent infrastructural losses, until outweighing gains or losses in investments on the short versus long-term.

Interventions, like DRR measures, are often approached from an adaptation point of view [36,37]. Here, issues of sustainability become relevant. Sustainability is defined in relation to three aspects. The first is resilience, which is the ability to persist and adapt to change [38]. The more resilient a DRR intervention is the less vulnerable society will be to coastal risks. The second aspect is on the additional value interventions may have for ecosystems and human activity by providing goods like clean water, regulating species or diseases, supporting existing ecological processes or economic activity, or contributing culturally for instance through recreation. This is often referred to as ecosystem services [28]. The third aspect is "no-regret", defined by the IPCC as adaptation policies, plans or options that "generate net social and/or economic benefits irrespective of whether or not anthropogenic climate change occurs" [39]. While this last aspect is less well documented in the DRR literature than the first two, there are increasing calls for adopting a no-regret policy in decisions that entail high levels of uncertainty [40]. A no-regret policy in risk management means taking climate-related decisions or action that make sense in development terms anyway, whether or not a specific climate threat actually materializes in the future. It is achieved by building resilience to changing economic, social and environmental conditions [41–43].

In order to map the social and political landscapes related to hazards, participatory assessments and stakeholder inclusion for understanding risks and measures are gaining prominence in the DRR literature [29,44,45]. For instance, Rød et al. [9] argue for a combination of top-down and bottom-up vulnerability assessments to increase a study's reliability. Their study shows the importance of taking into account perceptions of local-level authorities for raising awareness, achieving local acceptance of scientific studies, and integrating local knowledge in scientific research. Such assessment could then be used to support decision-making as to where necessary adaptive and preventive measures to climate change-related hazards should be carried out. Naess et al. [46] similarly argue that open-dialogue, participation and cooperation can facilitate proactive local adaptation to climate change effects. In addition to this, we argue that local ownership can lay the foundations for increased cooperation between research and policy, making policy more science-informed and research more policy relevant.

Following the above studies, this MCA has been structured to cover three main categories of criteria: Feasibility, Acceptability, and Sustainability (see Table 2). 'Feasibility' refers to the availability of (human, technical, time, and financial) resources required to implement the SA or can be acquired, whether the proposed measures address underlying concerns in society, whether the proposed location for implementing the SA is suitable for local needs and plans, and whether the proposed measure could have positive or negative impacts (e.g. economic) to society at large. 'Acceptability' refers to the expectations of stakeholders and recipients in the case studies sites. These actors may include civil society, interest groups, and influential individuals in society. 'Sustainability' addresses the relevance of the SA in the present and future, its impact upon human activity and ecosystems, and the resilience of the measures to future changes.

While it is common to allow stakeholders to identify criteria, the MCA methodology developed in the project needed to be applicable throughout all cases in RISC-KIT. Thus, criteria needed to be generic and broad to accommodate contextual interpretations. In order to do this, when defining criteria, the selection was made so that relevant and broadly defined criteria have been included; that each option can be judged against each criterion; that criteria are mutually independent; and so that criteria contain no double counting and are consistent with effects occurring over time [47].

Criteria were framed in a "scoring sheet" (see Table 2) which each participant would evaluate through a scale from -2 (probably no) to +2 (probably yes). Below each criteria, there was a main question participants needed to respond to through the scale provided, as well as three key points defining the criteria (these were not scored). A measure or SA that was deemed feasible could at the same time be deemed unsustainable or unacceptable. Thus, this scoring sheet would highlight both the benefits and drawbacks of each measure according to different criteria.

Table 2 Individual Scoring Sheets per Strategic Alternatives

SA 1					
Criteria	**Probably No -2**	**Possibly No -1**	**No effect 0**	**Possibly Yes 1**	**Probably Yes 2**
FEASIBILITY Can the SA be made to work?	**X**				
It is financially viable considering costs and revenues					
There is access to necessary human, infrastructure, knowledge, and technical resources					
It makes political sense					
ACCEPTABILITY Would the SA be accepted?			**X**		
Meets local expectations of economic, health, social, cultural and recreational benefits					
Enjoys local support from civil society and groups					
Perception of gains/needs outweigh perception of risk/threats					
SUSTAINABILITY Would the SA endure?		**X**			
It can be justified even if expected changes do not occur ("no-regret")					
It improves ecosystems and human life					
It is resilient to changes and disturbances					

2.3 Interactive tools to visualize risk information and support DRR measure evaluation

Risk communication is a multi-disciplinary field of research which is cutting across the social, behavioural, and natural sciences – gaining increasing interest among the 'experts' as the critical component to translate science to action. Kellens et al. [48] provide a review of empirical studies related to flood risk communication and Demeritt & Nobert [49] review the various changing models of good risk communication over time. The purpose of risk communication varies from simply raising awareness and increasing risk knowledge, to promoting acceptance of risks and management measures by improving relationships (build trust, cooperation, networks), enabling mutual dialogue and understanding, and involving actors in decision making [50].

In line with Pelling [29], we do not use communication strategies in participatory exercises for the purposes of reaching consensus, but rather to explore perceptions and highlight differences in opinion. Consequently, facilitation techniques in RISC-KIT's MCA are not used for the purpose of doing away with differences or to attain a middle ground, but to structure the format of the discussions and ensure all participants are given equal room to express themselves.

Translating scientific or 'expert' derived information to decision-makers comes with challenges [51]. There needs to be a balance between 'information overload' from the scientific models and the simple binary 'yes/no' requirements of many decision-makers. Scientists need to condense the available information into something more digestible for decision-makers to visualize and interpret. When assesseing how to visualise risk most effectively in different situations, five components can be identified: the purpose (why?), content (what?), target groups (for whom?), usage situation (when?), and visual formats (how?) [52].

The importance of risk communication needs to be seen in light of the shift towards multi-stakeholder decision-making, as can be seen in the EUs mandated participatory planning approach for different policies including the Floods Directive [53]. To do this, many users require targeted information to meet their needs. For instance, during public consultations in many areas in the EU, as part of the Floods Directive, it is common practice to present paper-based flood maps and management plans to stakeholders in order to improve risk knowledge and acceptance of measures by local stakeholders [54]. Other tools commonly used to increase knowledge, dialogue, learning and action among stakeholders are games, like for instance the 'Sustainable Delta Game' which uses a game board with cards and maps and a simulation model [55]. These types of interactive tools can support knowledge transfer in a user-friendly way and actively engage stakeholders in negotiation and decision making.

In RISC-KIT, in order to facilitate the participation of stakeholders during the MCA, several interactive tools were developed. The first is a paper-based set of cards, designed as an interactive communication and decision supporting tool during the MCA, in order to 1) communicate the selection of DRR measures to the stakeholders; 2) communicate and visualize the impact reduction of each individual DRR measure and the combined DRR measures i.e. Strategic Alternatives (SAs) to support comparison between measures; 3) support the stakeholders to select combinations of measures to formulate SAs; 4) support stakeholders to prioritize SAs; and 5) promote interaction and communication between the different stakeholders.

A template set of paper-based cards was designed for different types of DRR measures[2]. This template was adapted by each case study owner and filled out with data generated from the Bayesian Networks (see Jaeger et al. 2016 on this issue) from each case on their DRR measures (see Figure 1). Each set of cards included one card per DRR measure and/or combinations of DRR measures, and one zero alternative card (i.e. not implementing any measure) for comparison. The card colours were used to distinguish between the zero alternatives, hazard influencing DRR measures, vulnerability/exposure DRR influencing measures and the combined measures (i.e. SAs). In most cases a hazard scenario (e.g. return period) was chosen whereby the effects of the measures could be clearly seen. In the card template two sections of technical information were proposed for inclusion; hazard results e.g. flood inundation or erosion given a specific hazard scenario, and the impact results after implementing the DRR measure e.g. potential economic damages to houses. The cards also included a qualitative estimate of costs for implementing the DRR measure or SA. A sample card can be seen in Figure 1.

[2] Adapted based on those from the Sustainable Delta Game http://deltagame.deltares.nl

Figure 1 about here

2.4 MCA Steps

The MCA departed from the cards described above, to request stakeholders to assess the measures selected in each of the cases. The following steps were followed:

1. **Understand DRR measure impact reduction and prioritize strategic alternatives**: The impact reduction of each DRR measure is calculated using the Bayesian Network Analysis (see Jaeger et al. 2016, this issue) and visualized on individual cards for specific hazard scenarios. Stakeholders compare the impact reduction of different DRR measures against the zero alternative card to assess the most effective measures in reducing coastal impacts like floods, overwash and erosion. Interactively, stakeholders discuss the best possible combinations of measures and form SAs. Hereon, after reviewing the modelled results of the SAs (using the prepared cards), stakeholders collectively agree on the prioritized SAs that would be scored in the MCA.

2. **Score measures against criteria:** Stakeholders assessed the performance of each SA against criteria by first assigning a value ranging between -2 and +2, to each criterion per SA, on an individual basis using the scoring sheet in Table 2 (e.g. how feasible/sustainable/acceptable/suitable are sand dunes as a measure to prevent coastal erosion in your area?). Once stakeholders had assigned all scores, they used coloured post-it's with pre-assigned values (-2 to +2) and make them public to the other stakeholders by pasting in the MCA flip chart. Once all scores were visible, stakeholders could engage in a facilitated discussion and agree on one score per criteria. In those cases where consensus could not be reached, individual scores were instead averaged.

3. **Weigh criteria**: To indicate criteria's importance relative to the objective of the process (e.g., what criterion is most important to consider if sand dunes were to be implemented to reduce coastal erosion?). This was done through two main steps: first, stakeholders were handed out eight stickers each which needed to be distributed on an individual basis in between the three criteria to indicate their importance. The more stickers a criterion received the heavier its weight. The second step took place once stakeholders had assigned individual weights. Each participant indicated the individual weights on the MCA flip chart so that they would be visible to the group. Thereafter the group engaged in a facilitated discussion to agree on a weight per criteria. Equal weights could be given to more than one criterion; however, it is common in MCA to give different weightings to different options, reflecting their importance in the overall objectives. In those cases were consensus was not reached, weights were averaged. Criteria were only weighted once, as it is assumed that their importance is constant across all measures.

4. **Calculate weighted scores of criteria**: for each measure by multiplying scores times the weight for each criterion for all measures.

Table 3 Example of MCA chart and steps in Porto Garibaldi

Step 1: Choose composition of SAs

Step 2: Score criteria using a -2 (probably no) to +2 (probably yes) scale and using post it's

CRITERIA	Weights	SA1 Retreat		SA3 Education + Winter Dune		SA3 Winter Dune + Flood Resilience + Education + Strategic Retreat		SA4 Winter Dune + Flood Resilience + Education	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Feasibility	13	-1	-13	2	26	1	13	2	26
Acceptability	12	-2	-24	1	12	1	12	2	24
Sustainability	19	1	19	0	0	2	38	1	19
SUM		**-18**		**38**		**63**		**69**	

Step 3: Assign weights. Porto Garibaldi summed up individual weights for each criterion

Step 4: Calculate weighted score by multiplying the score (-2) times the weight (1).

Step 5: Calculate SUMS by adding the five weighted scores.

5. **Generate sums** per measure by adding the weighted scores for all criteria per measure(s) and entering the total value in the row titled "SUMS" at the end of the MCA Matrix. The measure with the highest weighted scores was stakeholders' preferred alternative. Table 3 shows an example of a complete MCA for Porto Garibaldi, Italy.

3. Discussion on method implementation in RISC-KIT cases

Case study owners (CSOs) were provided a short training session to carry out the MCA in their own cities along with a guide [56]. Most CSOs had not had any training in facilitation techniques previous to the project and most of them did not have a background in participatory methodologies. For this reason, the training session and guide included information on how to approach stakeholders; a description of how to prepare and use the material to maximize engagement of stakeholders during the session; guidelines on how to facilitate the session; and templates for recording descriptive and analytical data during the workshops. The observations that CSOs documented through these templates, along with a skype interview following the individual MCA sessions, are used as a basis for assessing the implementation of the methodology in RISC-KIT. In this section we summarize the findings from the implementation of the interactive and participatory MCA session in 9 of the 10 RISC-KIT cases.

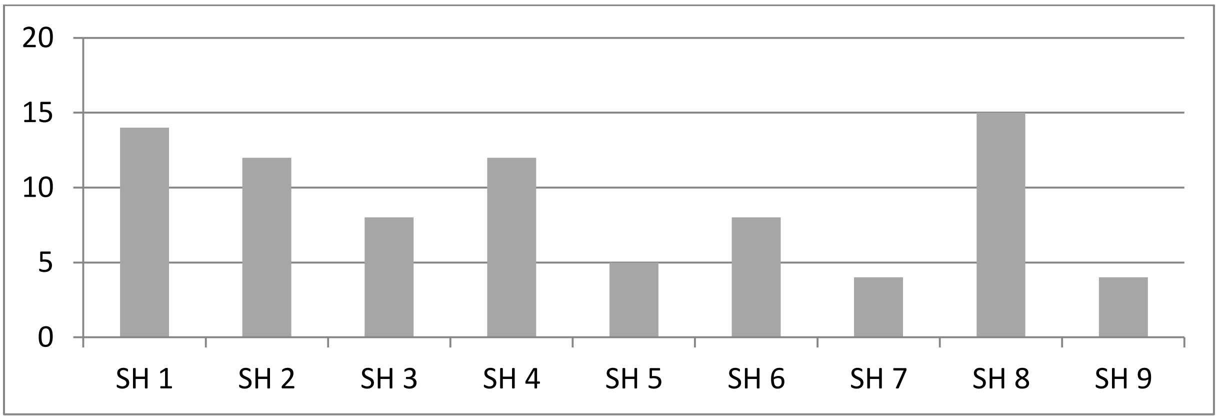
3.1 Stakeholders

The selection of stakeholders for the MCA session followed the stakeholder description described above. Ideally, all cases would have all SH groups evenly represented. In practice, some groups were overrepresented whilst others were not represented at all in some of the ses (see Table 4). Lack of representation was either due to people's unavailability or late cancelations, or because CSOs and key contact persons of the stakeholder groups deemed the issue as too sensitive and thus abstained from mixing certain groups of stakeholders. This was typically the case when inviting local inhabitants. For instance a stakeholder in one of the RISC-KIT cases argued that the "MCA exercise was entirely appropriate for the group assembled on the occasion, however it would be difficult to see how a similar exercise would be successful with local residents; you would be shouted down" [57].

Total numbers across all cases indicate an underrepresentation of three groups (Table 4): Consultants (SH 5), Citizen Groups (SH 7) and the Private Sector (SH 9). When it comes to Consultants and Citizen Groups, CSOs argued that the description and role of these two groups was too similar to other SH groups. For example the role of consultants was perceived as being similar to that of Academics (SH 4), and citizen groups sometimes had a similar role to that of local residents (SH 6). Thus, for future SH classifications, groups need to be more clearly defined or differentiated, and contextual nuances need to be better reflected. When it comes to the Private Sector, CSOs expressed having generally less contact with this group and thus having greater difficulty reaching these actors.

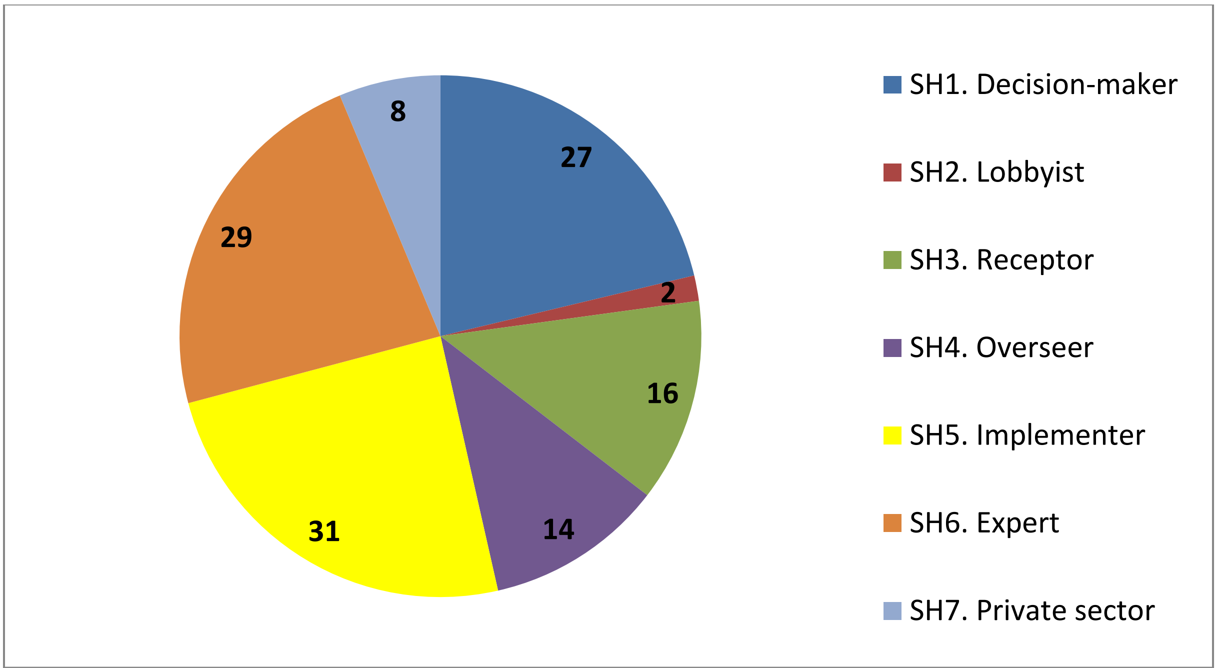
Another factor affecting the involvement of stakeholders in general was stakeholder fatigue due to competing demands from parallel projects, or lack of interest and time due to perceived low benefits from the project [58]. In several of the RISC-KIT cases, stakeholders were involved in several other research projects and struggled to find the time to engage in all of them. Thus, one recommendation emerging from the experiences of RISC-KIT is to take into account the number and extent of SH involvement throughout the project, to plan activities where SHs are required well in advance, and to have a clear purpose with these activities, in order to avoid stakeholder fatigue.

Table 4 Number of stakeholders represented across all cases



SH1 Coastal Managers; SH2 Land Use Planners; SH3 Civil Protection; CH4 Academic; CH5 Consultant; SH6 Local Resident; SH7 Citizen Group; SH8 Local Authority; SH9 Private Sector.

Table 5 Number of stakeholders by role across all cases



Stakeholders could have more than one role (but they could only represent one stakeholder group).

Gender and age are important factors that influence institutional culture as well as the type of policies and strategies implemented. Women and girls are more likely to be affected disproportionately both because of contextual cultural norms but also because women's accumulated skills, experiences and capabilities in times of natural catastrophes are often not adequately identified, recognized and promoted [37]. Gender representation amongst stakeholders across all RISC-KIT cases was unbalanced with a majority (56) being male and only 27 women. While the aim of the MCA was not to achieve statistical representation of the population and or decision-makers, we agree with the fact women's representation and participation in DRR is lower than men's at all levels, as has also been recognized in the implementation of the Hyogo Framework for Action. It is therefore not surprising to see the same unbalanced representation in most RISC-KIT cases. However, in order to obtain a gender-balanced approach to DRR [59], we argue that it is crucial to have more equal gender representation amongst stakeholders.

Besides from gender, age representation amongst stakeholders was also uneven with a large majority of stakeholders being over forty years of age (69 stakeholders) and only 14 below forty. Age is an important factor to consider in DRR because the nature of the problems and solutions demands involvement of different generations [60]. This was clearly reflected in some of the stakeholders' remarks when presenting long-term uncertain storm scenarios and the potential measures required to mitigate these: "some things need to be left for the next generations because we cannot care about everything" [61]. Thus, achieving greater gender and age representation at all levels is crucial for diversifying the issues that are being included in DRR agendas and which of these get prioritized.

3.2 Room setup and material

Logistical aspects like room size, room temperature, and the set-up of the room were crucial for maintaining participants engagement throughout the MCA, which in most cases lasted between 3-4 hours, and for creating a comfortable environment with enough visibility amongst participants and the interactive material, good sound, and undisturbed. Because the exercise required a certain level of concentration, getting the right room set-up was crucial. Many of the RISC-KIT cases that reported good stakeholder interaction and a good flow during the MCA exercise were also the cases that had better room set-ups, for instance with enough space for stakeholders to walk around, with a whiteboard to hang the material or draw their charts, with tables that could be re-arranged to facilitate large and smaller group discussions.

Besides room set-up, the MCA involved a great deal of preparatory work to get the venue and material arranged. It also required rehearsing through the session and ensuring that facilitators and co-facilitators had a good understanding of how and when the material would be used. Some cases admitted underestimating the time such preparatory work would take, resulting in for instance inadequate use of the material, lack of understanding on how the cards should be used, or the purpose of the material. This in turn had an impact on how stakeholders perceived and carried out the exercise.

The purpose of using interactive material (like the use colours, papers, and hands-on activities) is to enable a process of co-creation, where participants feel involved in the decision-making process rather than reproducing a teacher-pupil experience where communication only flows one-way (from the teacher to the pupil) [62]. While the MCA in RISC-KIT is an exercise and not a real-life situation where decisions will be made, the greater aim of the MCA was to create a safe environment that enabled open discussions, and where stakeholders could see the impact of a two-way communication process and how their voices could potentially impact others' perceptions. Having activities, colours, and material gives discussions a structured and a focused purpose which are important aspects for engaging participants in long meetings, over issues they are well-aware of and have first-hand experience with, but where participants might lack understanding or knowledge of how others' view the same issue.

3.3 Using the cards for selecting measures

The cards were used to compare the effectiveness (departing from the results of the Bayesian Network impact assessment) of the different DRR measures against the zero alternative. In most cases a scenario was chosen whereby the effects of the measures could be clearly seen. Considering the limitations in size of the cards, it's unrealistic to squeeze more than one scenario on a card. The more experienced stakeholders were found to question this scenario and other scenarios should be available to retrieve results when needed, including climate change. The stakeholders also raised some issues about the terminology of the scenario i.e. 1/100 year event which is difficult to understand.

In the card template two sections of technical information were proposed for inclusion; hazard results e.g. flood inundation or erosion given a specific event/scenario and the impact results after implementing the DRR measure e.g. potential economic damages to houses. Some CSOs (e.g. Faro) chose only to include the impact results. This adjustment is welcomed as many CSOs (e.g. Varna) found that the stakeholders were confused about which box to compare with the zero-alternative. However, in cases where the stakeholders were more experienced with reading this type of hazard information e.g. North Norfolk, this was not raised as an issue. The cards also included a qualitative estimate of costs for implementing the DRR measure or SA. Some stakeholders requested a more detailed Cost-Benefit Analysis of the DRR measures which would support their selection of SAs but understood this was outside the scope of the project.

Most of the CSOs followed the template and used simplified pie charts displaying the results from the Bayesian Network impact assessment. Impact categories such as high/medium/low and user friendly colours were successfully used to simplify the scientific language in the graph legends. However, some CSOs e.g. Kiel Fiord chose to only include the range of damages to a particular receptor e.g. 20 to 10% of boats damaged instead of pie-charts. Based on the facilitators' feedback, using such simplified expressions of damages rather than pie charts would be useful for stakeholders with less technical knowledge. Furthermore, using language such as the percentage change in damages e.g. reduced by 20% was suggested to help stakeholders interpret the results. Many CSOs had multiple receptors e.g. cars, buildings and infrastructure in their impact results and caused overcrowding of information. This is difficult to avoid unless the least impacted receptors are removed.

Based on a survey carried out amongst CSOs, the majority of cases agreed or strongly agreed that the cards helped them to communicate the model results to the stakeholders and aided their understanding and interpretation of the DRR measures. The cards were explained by the facilitators using a PowerPoint presentation whereby some cases went through each card one by one and others more explained the general components of the card. The facilitators found the cards useful for reiterating the modelled results and allowing the stakeholders to continuously refer back to them throughout the workshop. Interaction and debate among the different stakeholder groups was strengthened through the cards.

While the MCA Guide [56] suggested facilitators to first allow stakeholders to understand the individual DRR measures and then give them time to suggest possible combinations of measures to form SAs, most CSOs decided not to follow this process due to time limitations and the limited number of possible combinations of DRR measures. The two cases that followed the recommended steps found it to be very successful in stimulating interaction and discussion, although the model results for the combinations chosen were not instantly available [63,64]. The idea with this process was to stimulate as much interaction with stakeholders in the selection and prioritization of the SAs as possible in order to support stakeholder ownership of the selected SAs.

Overall, the general feedback for using cards as a communication and visualization tool for decision-support was very positive. For future uses of this tool, it is important to consider the target stakeholders and adapt the level of information on the cards based on their experience. Results should be simplified to show the most relevant and powerful information while removing as much of the technical jargons as possible. It is recommended that a draft set of cards is tested with end-users or professionals to get direct feedback on readability, clarity and use of both scientific and graphical information

3.4 Scores

CSOs reported three types of challenges during the scoring part of the workshop. The first was related to the logistical aspects of the scoring exercise. For instance, some cases decided not to use the material indicated in the guide because they had not prepared for it or had not understood the use of it and instead opted for a strongly led discussion. For some cases this caused a 'teacher-pupil' feeling where CSOs ended up talking, writing, and doing all of the steps of the exercises by themselves. This naturally defied the purpose of the exercise which was to give a sense of interaction and ownership. Other CSOs used the material but did not come up with a strategy to keep the material in order. "It was tricky with all the post-its and the different colours. People forgot what each colour represented" [57]. Some CSOs felt that the method needed some expert knowledge on communication (know-how) and that scoring needed strong facilitation [65]. In general, CSOs reported having initial trouble with getting stakeholders on track, but once they scored the first SA, stakeholders felt more confident and, in most cases, the exercise proceeded smoothly.

The second type of challenges was related to people's perceptions about the measures. For instance, some CSOs reported that in their cases measures, which were not standard already, had a tendency to be scored negatively: "people who did not understand the measures tended to value them more positively than stakeholders with practical experience who tended to be more pessimistic about their implementation and at the same time appeared to see less opportunity for trying new ideas" [65]. Several CSOs reported that stakeholders did not base their judgement of the SAs upon the results presented during the first part of the workshop (results from the project's Bayesian analysis). Rather, stakeholders seemed to have relied on their own values, knowledge, and experience, and at times "people tended to change their opinion during discussion, following the people with 'practical knowledge'", rather than our results (ibid.).

The third challenge was the lack of cost-benefit analyses particularly in relation to the maintenance of these measures. For instance, a CSO explained that "practitioners perhaps need to have 'something to grip' before accepting it [the SA] as 'feasible'?! E.g. building a working prototype of a flood proof mooring could change their opinion again?!" [65]. Most CSOs explained that the question of costs over time and in relation to benefits was often brought up by stakeholders [57]. In some cases, this undermined the scoring of SAs, because stakeholders felt that they were not well equipped to make an assessed judgement and that they needed the full picture before being able to make a choice [61,63,66].

Despite the challenges named above, most CSOs were satisfied with the outcome and how the scoring was carried out. Some were surprised at the clarity and unanimity of the outcome. Those CSOs who used the material adequately were surprised to see that the technique actually enabled a more structured discussion and that it was useful for getting stakeholders to engage [63,66].

3.4 Weights and criteria

In contrast to the scores, assigning weights was perceived to be easier, and in most cases, weighting went smoothly, so "weighting was very quick and straightforward" [57]. However, CSOs reported some challenges. In some cases, stakeholders felt that the criteria were too general and that it would have been better to score the sub-questions. For some stakeholders economic and political aspects went hand in hand, whilst other stakeholders wished these two aspects would have been divided into different criteria.

CSOs used at least two different methods for adding up the weights: some replicated the individual method of allocating the eight stickers in between criteria through a group discussion to reach a compromise on the amount of stickers; others decided to add up the individual stickers and come up with an average per criteria, like in Porto Garibaldi (see Table 3).

One of the cases identified some dependency between criteria: acceptability could influence feasibility, because "if people demand from their governments certain actions, then decision-makers will have to respond to these demands or else they risk their political posts" [61]. This is an interesting observation that might be most relevant for the cases with decentralized governance systems, where some decision-makers are elected rather than assigned. In cases where the decision-making bodies are far away from the places where the risk (and solutions) are taking place, the connections and level of impact that civil society may have upon governments may be weaker. In such cases with more centralized governance systems, acceptability might be more independent from feasibility.

3.5 Perceptions of a participatory MCA

The ways in which the MCA was perceived and used by CSOs and stakeholders was largely dependent on the particular contexts of each of the cases. For some cases with longer experience of DRR work and participatory approaches like North Norfolk or Porto Garibaldi, the MCA was a useful tool to communicate results and engage in a fun exercise but was not considered a useful tool to be used in decision-making. For instance, case study owners (CSOs) in North Norfolk highlighted that "although the MCA was of genuine interest, given the 'mature' nature of defence engineering, flood forecasting, crisis management and evacuation planning already in place in North Norfolk, it is difficult to see the MCA workshops changing current policy and practice" [57]. Whilst in other cases where disasters occur with less frequency or where interaction and communication between agencies and civil society is not as frequent like in Kristianstad in Sweden, Varna in Bulgaria, or Kiel Fjord in Germany, the MCA was able to generate discussions that triggered further discussions and community engagement.

A general comment across all MCA reports submitted by CSOs was that the MCA workshop had been a good mechanism to bring people together. In all cases, CSOs reported that the MCA was a useful tool to disseminate project results and methodologies. Several CSOs reported that, following the MCA session, stakeholders became interested in the RISC-KIT tools and whether these could be acquired, whether they would be open-access, and whether they would be able to use them after the project ended [63]. [3] In some cases, stakeholders were eager to learn whether there would be a "second phase" of the project, or whether the tools would be further developed for widespread use [61].

The MCA was a good exercise for testing the project's research assumptions, for rethinking some of the granted assumptions from which the project departed, and for obtaining better understanding of the divide between research priorities and every-day life concerns. In several cases, CSOs reported how stakeholders preferred to rely on their own experiences and assumptions than on the scientific evidence provided from the project [64]. In some of the cases like Kristianstad, this led stakeholders to choose an unexpected SA, even though our evidence showed this measure was not the most effective one [61]. In other cases like Porto Garibaldi or Praia de Faro, we got a better appreciation for time in relation to priorities, and the fact that planning 100 years ahead, is too long into the future for most people. This means that data on, for example climate change, which is based on (uncertain) long-term scenarios, is too far away from the near reality of local inhabitants and decision-makers. Thus, no matter how convincing we think our evidence is, showing future scenarios of potential catastrophic events might not necessarily convince people of the need to implement long term risk reduction measures. Political, cultural and economic factors continue to play a major role on the decision to implement or not a measure, as well as what measures are deemed adequate.

4. Conclusions

This article introduced a methodology to carry out a participatory and interactive MCA in DRR. The aim of the MCA in RISC-KIT was to map the diversity of perspectives that may be taken on a particular set of measures, to highlight the key features underlying the differences in opinions and to provide a framework for debate. More specifically, the MCA introduced here was used as a way facilitate the communication and presentation of project results in a coherent and contextualized manner to various actors using interactive materials including paper-based cards; as a way to capture other types of knowledge, such as local every-day experiences, socio-economic and political factors that might affect how the proposed measures are perceived; and as a way of facilitating interaction between actors and raising awareness of risks and potential measures. The outcomes of this interactive exercise should not be interpreted as providing the basis for decision-making, but rather they should be understood as a way of facilitating constructive discussion and knowledge exchange.

While the methodology was designed to allow academics and practitioners that do not necessarily have a social science background to implement it, the methodology requires contextualization. The experience in RISC-KIT highlights that the ways in which the MCA was

[3] All materials and guides are available through the project's home page http://risckit.eu/

found useful varied across the nine cases. In cases, like Tordera Delta, North Norfolk or Porto Garibaldi, with a longer history of DRR work and stakeholder participation, the MCA might be useful to facilitate knowledge transfer between researchers and practitioners. In cases, like Kristianstad or Praia de Faro, the MCA can have an additional benefit of raising awareness and bringing different actors together. In cases like Varna and Kiel Fjord where participatory approaches have not been widely used, the MCA provided a forum for discussion and a safe space to exchange opinions. In cases like La Faute Sur Mer where issues around DRR are sensitive due to the recent history of fatal disasters, the MCA was a channel of communication with a portion of the population.

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Figure 1 Sample cards provided to stakeholders to develop their own cards